Leading Charm in Hadron-Nucleus Interactions in the Intrinsic Charm Model*

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One of the most striking features of charm hadroproduction is the leading particle effect: the strong correlation between the quantum numbers of the projectile and the final-state charm hadron. For example, more D^- than D^+ are produced at large x_F in $\pi^- A \to D^\pm X$ interactions. Such correlations contradict the perturbative QCD factorization theorem which predicts that heavy quarks hadronize through jet fragmentation functions independent of the initial state.

While leading charm effects are well established for D mesons, observations of charm baryons are more rare. Two experiments with $\Sigma^-(dds)$ beams promise to clarify the situation in the baryon sector. The hyperon beam, with a strange valence quark, presents a unique opportunity to study the flavor dependence of leading charm hadroproduction since both charm and charm-strange baryons can be leading.

In previous work [1], a QCD mechanism which produces leading charm at large x_F was introduced. An important feature of the model is coalescence, the process through which a charm quark hadronizes by combining with quarks of similar rapidities, such as projectile spectator valence quarks. In a gauge theory the strongest attraction is expected to occur when the spectators and the produced quarks have equal velocities. Thus the coalescence probability should be largest at small relative rapidity and rather low transverse momentum where the invariant mass of the $\overline{Q}q$ system is minimized, enhancing the binding amplitude.

This coalescence occurs in the initial state where the projectile wavefunctions of *e.g.* the π^-, p and Σ^- can fluctuate into Fock configurations containing a $c\overline{c}$ pair such as $|\overline{u}dc\overline{c}\rangle$, $|uudc\overline{c}\rangle$ or $|ddsc\overline{c}\rangle$ respectively. The longest-lived fluctuations in states with invariant mass M have a lifetime of $\mathcal{O}(2P_{\rm lab}/M^2)$ in the target rest frame where $P_{\rm lab}$ is the projectile momentum. Since the comoving charm and valence quarks have the same rapidity in these states, the heavy quarks carry a large fraction of the projectile momentum and can thus readily combine to produce charm hadrons with large longitudinal momentum and dominate the hadroproduction rate at large x_F. This is the underlying assumption of the intrinsic charm model in which the wavefunction fluctuations are initially far off shell. However, they materialize as charm hadrons when light spectator quarks in the projectile Fock state interacts with the target.

We refine the intrinsic charm model of Ref. [1], including both the minimal Fock state and all the configurations with an additional $q\overline{q}$ pair. We have applied a simple counting scheme to determine the relative contribution of each state to the final charm hadron distribution. The model compares rather favorably to the x_F distributions measured by WA89 and produces reasonable agreement with their measured D^-/D^+ asymmetry while falling short of the D_s^-/D_s^+ and $\Lambda_c/\overline{\Lambda}_c$ data at intermediate x_F.

Further, we have made predictions for charm hadron production at the energy of SELEX for both Σ^- and π^- projectiles. High statistics data on charm production from a combination of these projectiles could eliminate certain classes of models and perhaps distinguish between coalescence in the initial state, as in the intrinsic charm model, and in the final state.

[1] R. Vogt and S.J. Brodsky, Nucl. Phys. **B438** (1995) 261; Nucl. Phys. **B478** (1996) 311.

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